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(54) **Twist drill**

(57) In a twist drill comprising a shank, in addition to at least one helical, chip transporting flute, also a cutting insert (3) is included with at least one cutting edge (5), located between a front or top surface (6) and a flank surface (7), which extends at an angle to a reference plane intersecting the centre axis of the drill shank. In connection with at least a part of the cutting edge (5), a second flank surface (9) is provided, which extends at another angle in relation to said reference plane than the first-mentioned flank surface (7).

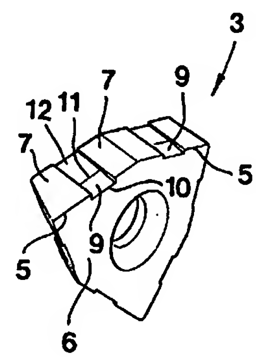

Fig 2

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Description

Technical Field of the Invention

[0001] This invention relates to a twist drill of the type that comprises a shank having one or more helical, chip-transporting grooves, each one of which co-operates with at least one cutting insert having at least one cutting edge located between a front or top surface and a flank surface, which extends at an angle to a reference plane intersecting the centre axis of the drill shank.

Brief Description of the Appended Drawings

[0002] In the drawings:

Fig 1	is a perspective view of a twist drill having two cutting inserts manufactured according to the principle of the invention,
Fig 2	is a perspective view of an individual cutting insert manufactured according to the invention,
Fig 3	is an enlarged planar view, which displays schematically the wavy form of the bottom of a bore hole,
Fig 4	is a partial section showing the wavy form of the bore hole bottom in an extremely enlarged scale,
Fig 5	is an enlarged partial section through the cutting insert according to fig 2 in connection with a cutting edge,
Fig 6 and 7	are analogous sections showing alternative embodiments of the invention, and
Fig 8	is a schematic section through a cutting insert shown in relation to the geometric centre axis of the drill.

[0003] Before the description is continued, it should be pointed out that the twist drill shown in fig 1 includes two cutting inserts which co-operate with a corresponding number of chip-transporting flutes in the shank. Although these flutes are helicoidal and not strictly helical, the type of tools in question are called twist drills by those skilled in the art. Henceforth, the chip-transporting flutes or grooves will thus be described as helical, although they in a geometric sense are helicoidal.

[0004] It should also be pointed out that the number of flutes may deviate from two and that more than one cutting insert may co-operate with each individual flute.

Background of the Invention

[0005] Generally, twist drills tend to oscillate in the direction of torsion during machining. When the drill tool is in operation, the shank oscillates to and fro in the direction of torsion, whereby the same alternately is extended and shortened. This cycle creates a regenerative effect in the form of a feed-back vibration mechanism, which briefly may be described in the following way.

[0006] When a drill shank oscillates in the above indicated way, the individual cutting edge cuts a wavy surface in the bottom of the bore hole, as is generally illustrated in figs 3 and 4. Thereafter, when either one and the same cutting edge or a subsequent cutting edge (depending on whether the tool includes one or more cutting edges which cut in the same path) runs across this wave surface, a secondary wave surface is created (compare the continuous and dashed wave lines, respectively, in fig 4). In practice, this means that the nominal chip thickness will vary depending on the phase position or phase displacement between the waved surfaces in the bottom of the bore hole. When the nominal chip thickness varies, the cutting force will also vary. This constitutes the driving force behind the above-mentioned vibration mechanism. If the chip width is increased (due to the fact that the diameter of the drill is increased at the same time as the other properties of the drill remain intact) beyond a certain value, the mechanical system is no longer capable of resisting, and therefore the oscillating amplitude will grow and become unstable. With "the mechanical system" is here understood primarily the helically cut drill as such. This mechanical system is primarily effected by the length of the drill shank. More precisely, a longer drill becomes more unstable torsion-directionally than a shorter one.

[0007] If the regenerative effect is triggered off, i.e. the amplitude of the vibrations grows, after a short while the vibration level will be very high. However, the growth of the amplitude decreases after a time as a consequence of other mechanisms, for instance the fact that the cutting edge cannot cut itself free.

Objects and Features of the Invention

[0008] The present invention aims at solving the above mentioned problems and at providing an improved twist drill. Thus, a primary object is to provide a twist drill which directly at the beginning of use counteracts the development of an unstable regenerative effect, i.e. increasing oscillating amplitude in the drill shank when the drill works.

[0009] According to the invention, the above-mentioned object is attained by the features defined in the characterizing clause of claim 1. Preferred embodiments of the invention are furthermore defined in the dependent claims.

Detailed Description of Preferred Embodiments of the Invention

[0010] The drill tool shown in fig 1 includes a shank designated 1, which at a rear end transforms into an attachment part 2 having a shape which is suitable for

attachment of the tool in a conventional holder. The shank has two cutting inserts 3 at the front end or tip thereof. In the example shown, these cutting inserts are of a detachable type. More precisely, they may be fastened by means of screws in seats in the area of the tip of the shank. In the example, a number of flutes 4 corresponding to the number of cutting inserts extend backwards from the tip of the shank. These flutes are helical and have the purpose of evacuating chips, which are cut loose by the cutting inserts 3, out of the drill hole.

[0011] In fig 2 the individual cutting insert 3 is illustrated in an enlarged scale. In this embodiment example, the cutting insert has a hexagonal basic shape and three pairs of co-operating main cutting edges 5, 5 that are active in pairs during operation. In other words, the cutting insert 3 may be readjusted between three different positions in the appurtenant seat.

[0012] Each separate main cutting edge 5 is provided or located between, on one hand, a front or top surface 6 on the cutting insert and, on the other hand, a flank surface 7 extending at an acute angle to the front surface 6 (or - if the front surface has a complex, uneven shape - an arbitrary neutral plane which is generally parallel to the front surface). According to existing standard, the angle of the flank surface 7 in relation to the front surface 6 is within the range of 78-84°, i.e. the complementary angle β thereof (see fig 5-7) is within the range of 6-12°.

[0013] An underside opposite the front surface 6 on the cutting insert is designated 8 in fig 5-7.

[0014] As far as the shown drill tool and the cutting insert thereof have been described hitherto, the same are in all essentials previously known.

[0015] New and characteristic for the present invention is that a second flank surface 9 is provided in connection with at least a part of the individual main cutting edge 5 of the cutting insert 3, the angle of which surface in relation to the front surface 6 (or a neutral plane through the cutting insert substantially parallel therewith) is larger than the angle of the first flank surface 7 in relation to the same. Advantageously, the angle of the second flank surface 9 in relation to the front surface is within the range of 87-89°, i.e. the complementary angle α according to fig 5-7 is within the range of 1-3°.

[0016] In the embodiment according to fig 2 and 5 as well as in the alternative embodiment according to fig 6, the second flank surface 9 extends only along a certain part of the length of the individual main cutting edge 5. In doing so, the flank surface 9 connects to a secondary, shorter cutting edge or edge formation 10, which, in the embodiments according to fig 5 and 6, is displaced depthwise in relation to the main cutting edge 5, which only connects to the first flank surface 7. More precisely, the flank surface 9 together with appurtenant secondary edge 10 are displaced a distance into the bit body, the surface 9 transforming, via a breaking line 11, into a surface 12 which may be parallel to the flank surface 7, i.e. the angles β and γ are equally large. In practice, the length "x" of the surfac 9 should be less than the length "y" of the surface 12. It should also be pointed out that the countersink, which is delimited by th flank surfaces 9 and 12, should have a width which is considerably less than the total width of the main flank surface 7. In other words, the length of the secondary edge 10 should be considerably less than the length of the individual main cutting edge 5.

[0017] In the embodiment according to fig 6, the surfaces 9 and 12 are provided on a projection, which protrudes somewhat in relation to the flank surface 7. In other respects, the same dimension and angle conditions as referred to above in respect of the embodiment according to fig 5 pertain also here.

[0018] In fig 7, a third embodiment is shown according to which the second, steeper flank surface 9 extends along the entire length of the cutting edge 5. Thus, in this embodiment, the second flank surface 9 transforms directly in the flank surface 7 via the breaking line 11. In other words, in doing so, countersinks and projections, respectively, of the type shown in fig 5 and 6, are missing.

[0019] In fig 8 is illustrated how the individual cutting insert 3 of the drill may also be placed in an oblique position in relation to the reference plane which is represented by the geometric centre axis "c" (the axis of rotation) of the drill. The essential thing according to the invention is that the second flank surface 9 extends at another angle in relation to said reference plane than the first flank surface 7.

The Function and Advantages of the Invention

[0020] By forming the cutting insert in the above mentioned way with not only one single plane flank surface extending at, for instance, 78-84° angle to the individual cutting edge, but also with a second flank surface extending at a steeper angle to the front surface of the cutting insert, it has turned out that the drill cannot oscillate with a higher amplitude than the one the drill gets by cutting itself free; provided that the flank surface does not plasticize the material of the work piece. Such a plasticizing of the material dampens the oscillations by virtue of the work involved in the plasticizing process. Either the amplitude of the oscillations is limited or the oscillation frequency decreases below the frequency, which is natural for the tool, i.e. the neutral or inherent frequency of the tool. The amplitude with which the tool oscillates when the same cannot oscillate in the neutral frequency thereof but at a lower frequency will of necessity become lower by the fact that the oscillations in these frequencies are dampened faster. In order for the above-mentioned regenerative effect to be triggered off, i.e. the oscillating amplitude to grow, at a certain frequency, it is required that the transfer function of the system at this frequency, represented in the plane complex of numbers, should have a negative real part. At lower frequencies, the real part becomes positive.

[0021] If the drill tool cannot oscillate with higher frequencies, neither the regenerative effect can become unstable, i.e. triggered off (see Veck M Teipel K "Dynamisches Verhalten spanander Werkzeugmaschinen", Springer-Verlag 1977, ISBN 3-540-08468-1).

[0022] A substantial advantage of the present invention is that the same enables use of twist drills larger in length and/or diameter than previously known drills with the corresponding performance. Thus, the manufacturer may choose between either extending the shank of the drill or making the cutting inserts with longer cutting edges (i.e. larger diameter) or more efficient cutting edges without the regenerative effect becoming unstable. Of course, an extension of the drill shank may also be combined with an increase of the diameter.

Claims

1. Twist drill including a shank (1) having one or more helical, chip-transporting flutes (4), each one of which co-operates with at least one cutting insert (3) having at least one cutting edge (5) located between a front or top surface (6) and a flank surface (7), which extends at an angle to a reference plane intersecting the centre axis (C) of the drill shank, **characterized** in that a second flank surface (9) is provided in connection with at least a part of the cutting edge (5), which flank surface extends at another angle in relation to said reference plane than the first-mentioned flank surface (7).

2. Twist drill according to claim 1, **characterized** in that the angle of the second flank surface (9) in relation to said reference plane is larger than the angle of the first flank surface (7) in relation to the same.

3. Twist drill according to claim 2, the angle of the first flank surface (7) in relation to said front surface or a neutral plane through the cutting insert being within the range of 78-84°, **characterized** in that the angle of the second flank surface (9) in relation to said neutral plane is within the range of 87-89°.

4. Twist drill according to any one of the preceding claims, **characterized** in that the second flank surface (9) extends only along a certain part of the entire length of the edge (5).

5. Twist drill according to claim 4, **characterized** in that a secondary cutting edge (10) between the front surface (6) and said second flank surface (9) is displaced depthwise in relation to a main cutting edge (5) which only connects to the first flank surface (7).

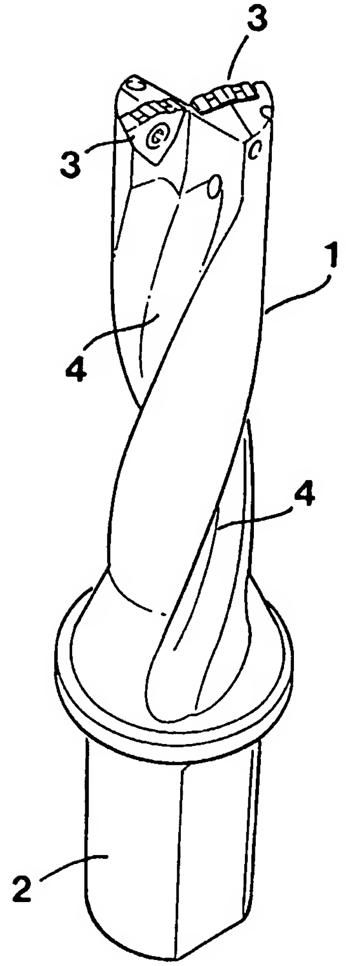

Fig 1

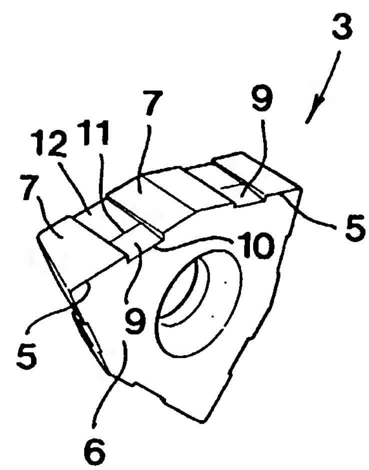

Fig 2

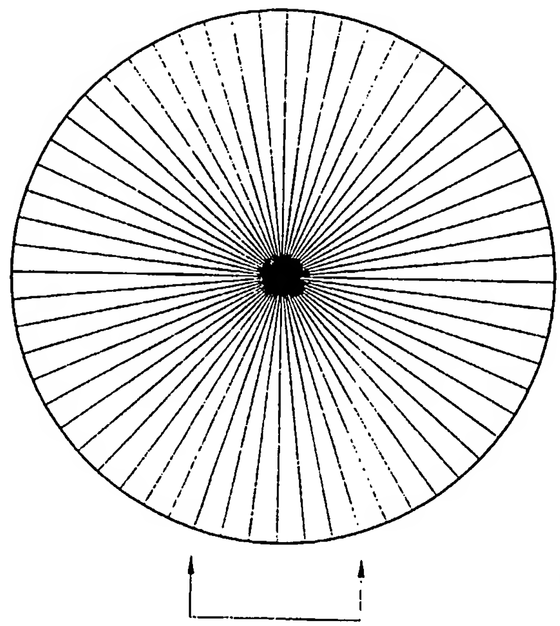

Fig 3

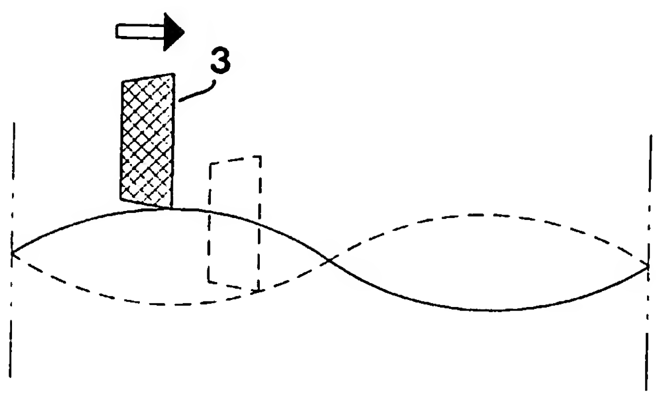

Fig 4

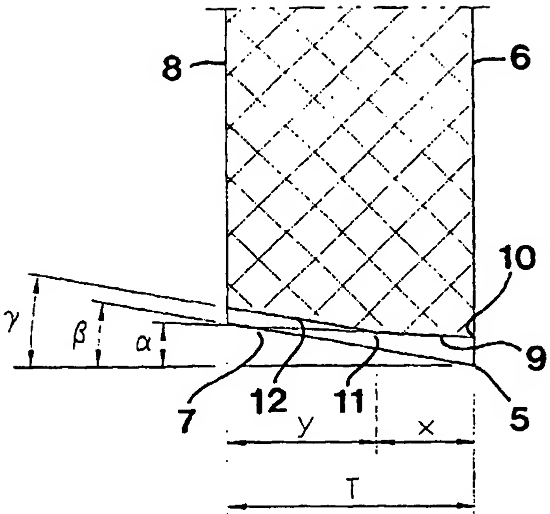

Fig 5

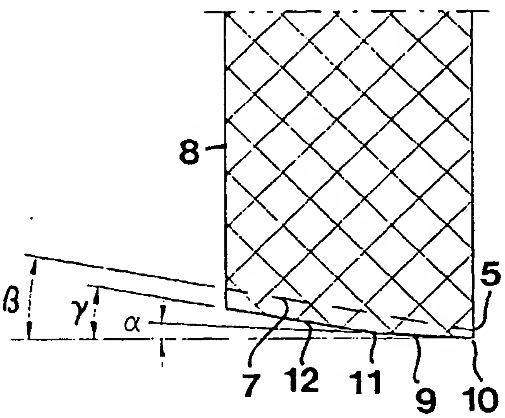

Fig 6

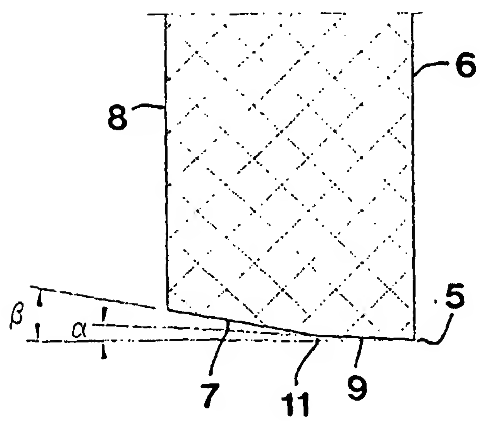

Fig 7

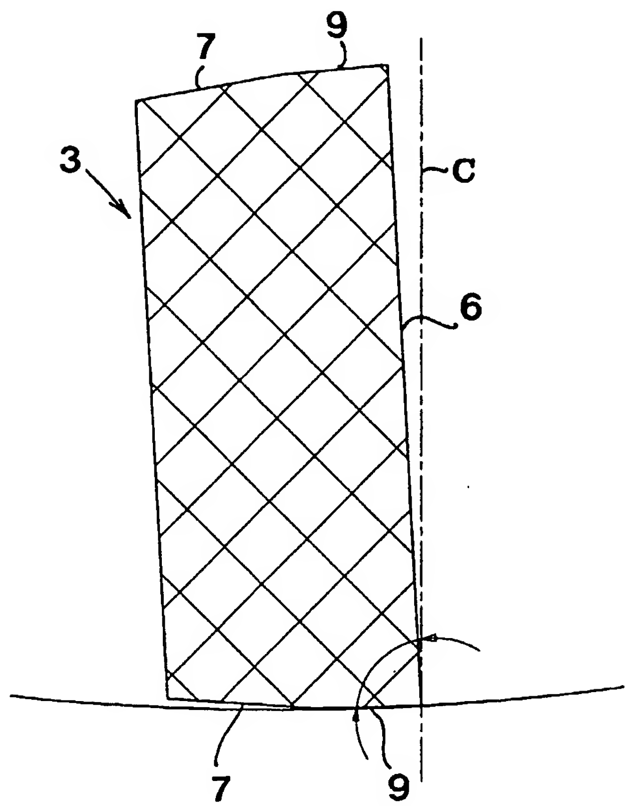

Fig 8

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EUROPEAN SEARCH REPORT

Application Number
EP 99 11 5873

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 89 08520 A (GREENFIELD IND INC) 21 September 1989 (1989-09-21) * page 8; figures 1,2 *	1-5	B23B27/14 B23B51/04
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B23B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	17 November 1999	Fischer, M

CATEGORY OF CITED DOCUMENTS

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